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IIT Academy., India

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(9:30 am - 12:30 pm)

Question Paper

Solutions

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PHYSICS

1. **The magnetic field of a plane electromagnetic wave is given by:**

$\vec{B} = B_0\hat{i}\left[\cos(kz-\omega t)\right] + B_1\hat{j}\cos(kz+\omega t)$ **Where** $B_0 = 3\times10^{-5}T$ **and** $B_1 = 2\times10^{-6}T$ **.**

The rms value of the force experienced by a stationary charge $Q = 10^{-4}C$ **at z = 0 is**

1. 0.6 N **2. 0.1 N** **3.** $3\times10^{-2}N$ **4. 0.9 N**

Ans: 1

Sol: $F_{rms} = g\sqrt{\left(\frac{CB_0}{\sqrt{2}}\right)^2 - \left(\frac{CB_0}{\sqrt{2}}\right)^2}$

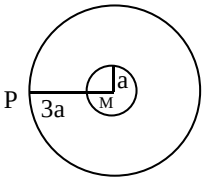
$= 10\sqrt{\left(\frac{3\times10^{-5}}{\sqrt{2}}\right) + \left(\frac{2\times10^{-6}}{\sqrt{2}}\right)} \times 3\times10^8 = 0.63$

2. **A solid sphere of mass 'M' and radius 'a' is surrounded by a uniform concentric spherical shell of thickness 2a and mass 2M. The gravitational field at distance '3a' from the centre will be:**

1. $\frac{2GM}{3a^2}$ **2.** $\frac{GM}{9a^2}$ **3.** $\frac{2GM}{9a^2}$ **4.** $\frac{GM}{3a^2}$

Ans: 4

Sol: **Field at** $P = \frac{GM}{(3a)^2} + \frac{G(2M)}{(3a)^2}$



Field = $\frac{GM}{3a^2}$

3. **A moving coil galvanometer has resistance** 50Ω **and it indicates full deflection at 4 mA current. A voltmeter is made using this galvanometer and a** $5\,k\Omega$ **resistance.**

The maximum voltage, that can be measured using this voltmeter, will be close to:

1. 10 V **2. 15 V** **3. 40 V** **4. 20V**

Ans: 4

Sol: $I_{max} = 4MA$

$R_G = 50\Omega$

In voltmeter

$V = I_{max}\left(R_s + S_K\right)$

V □ 20

4. **For a given gas at 1 atm pressure, rms speed of the molecules is 200 m/s at 127°C. At 2 atm pressure and at 227°C, the rms speed of the molecules will be:**

1. $100m/s$ **2.** $80m/s$ **3.** $80\sqrt{5}m/s$ **4.** $100\sqrt{5}m/s$

Ans: **4**

Sol: $V_{rms}\alpha\sqrt{T}$

$\frac{V_2}{200} = \frac{500}{400}$

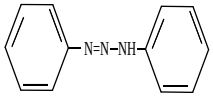
$V_2 = 100\sqrt{5}$

5. **Taking the wavelength of first Balmer line in hydrogen spectrum (n = 3 to n = 2) as 660 nm, the wavelength of the 2nd Balmer line (n = 4 to n = 2) will be:**

1. 642.7 nm **2. 889.2 nm** **3. 488.9 nm** **4. 388.9 nm**

Ans: **3**

Sol: **1st line Balmer**



$\lambda = \frac{36}{5R} = 660$

$\frac{1}{\lambda_2} = R\left(\frac{1}{4} - \frac{1}{16}\right)$ $\lambda_2 = \frac{16}{3R}$ $\frac{1}{R} = \frac{5\times 660}{36}$

$\lambda_2 = \frac{16}{13}\times\frac{5\times 660}{36}$

$\lambda_2 = 488.9$

6. **The pressure wave,** $P = 0.01\sin\left[1000t - 3x\right]Nm^{-2}$**, corresponds to the sound produced by a vibrating blade on a day when atmospheric temperature is 0°C. On some other**

day when temperature is T, the speed of sound produced by the same blade and at the same frequency is found to be $336ms^{-1}$. Approximate value of T is:

1. 12°C **2. 11°C** **3. 15°C** **4. 4°C**

Ans: 4

Sol: $V_{sound}\alpha\sqrt{T}$

$$\frac{336\times 3}{1000}=\sqrt{\frac{T_2}{273}}$$

$$T_2=277K$$

$$T_2=4^oC$$

7. The following bodies are made to roll up (without slipping) the same inclined plane from a horizontal plane : (i) a ring of radius R, (ii) a solid cylinder of radius $\frac{R}{2}$ and (iii) a solid sphere of radius $\frac{R}{4}$. If, in each case, the speed of the center of mass at the bottom of the incline is same, theratio of the maximum heights they climb is:

1. 2 : 3 : 4 **2. 4 : 3 : 2** **3. 10 : 15 : 7** **4. 14 : 15 : 20**

Ans: 3

Sol: $Mgh=\frac{1}{2}mV_{cm}^2(1+K)$

$$Ratio=1+1:1+\frac{1}{2}:1+\frac{2}{5}$$

$$=20:15:14$$

8. An NPN transistor is used in common emitter configuration as an amplifier with $1k\Omega$ load resistance. Signal voltage of 10 mV is applied across the base-emitter. This produces a 3 mA change in the collector current and $15\mu A$ change in the base current of the amplifier. The input resistance and voltage gain are:

1. $0.33k\Omega,300$ **2.** $0.67k\Omega,300$ **3.** $0.33k\Omega,1.5$ **4.** $0.67k\Omega,200$

Ans: 2

Sol: $\frac{I_C}{I_B}=200$

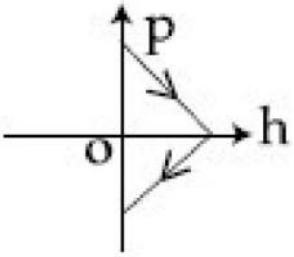
$I_B R_i = V$

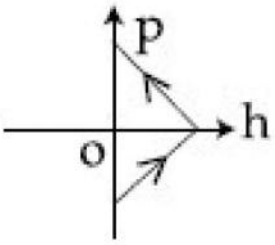
$R_i = \frac{2}{3}$

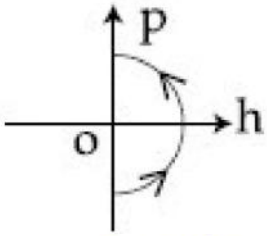
Voltage gain = $\frac{I_C}{I_B} \times \frac{R_C}{R_I}$

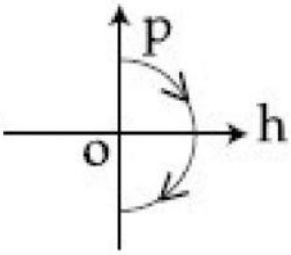
Voltage gain = 300

9. **A ball is thrown vertically up (taken as +z-axis) from the ground. The correct momentum – height (p-h) diagram is:**

1. 

2. 

3. 

4. 

Ans: 4

Sol: $v^2 - u^2 = -2gh$

$v^2 = v^2 - 2gh$

$p^2 = A - Bh$

10. **The electric field of light wave is given as** $\vec{E} = 10^{-3}\cos\left(\frac{2\pi x}{5\times10^{-7}} - 2\pi \times 6 \times 10^{14} t\right)\hat{x}\frac{N}{C}$.

The light falls on a metal plate of work function 2eV. The stopping potential of the photo-electrons is:Given, E (in eV) $= \frac{12375}{\lambda\left(in\ \overset{0}{\text{A}}\right)}$

1. 0.48 V **2. 2.48 V** **3. 0.72V** **4. 2.0**

Ans: 1

Sol: $h\nu = h\nu_0 + s.potential$

$$\frac{12375}{5000} = w + s.potential$$

$$2.48 = 2ev + s.potential$$

$$stop\ \ potential = 0.4eV$$

11. A string is clamped at both the ends and it is vibrating in its 4th harmonic. The equation of the stationary wave is $Y = 0.3\sin(0.157x)\cos(200\pi t)$. The length of the string is: (All quantities are in SI units.)

1. 40 m **2. 20 m** **3. 80 m** **4. 60 m**

Ans: 3

Sol: In 4th harmonic

$$\ell = \frac{4.\lambda}{2} = 2\lambda$$

$$\lambda = \frac{2\pi}{k} = \frac{2\times 3.14}{0.157} = 20 = 40m$$

$$2\lambda = \ell = 80m$$

12. A signal $A\cos\omega t$ is transmitted using $\upsilon_0 \sin\omega_0 t$ as carrier wave. The correct amplitude modulated (AM) signal is:

1. $\upsilon_0 \sin\omega_0 t + A\cos\omega t$

2. $\upsilon_0 \sin\omega_0 t + \frac{A}{2}\sin(\omega_0 - \omega)t + \frac{A}{2}\sin(\omega_0 + \omega)t$

3. $(\upsilon_0 + A)\cos\omega t \sin\omega_0 t$

4. $\upsilon_0 \sin\left[\omega_0(1 + 0.01A\sin\omega t)t\right]$

Ans: 2

Sol: Mododulater wave = $\left((A_C + V_0\sin\omega_0 t)\cos\omega t\right) \rightarrow w_{rms}$

$= (V_0 + A\cos\omega t)\sin\omega_0 t$

$$= V_0 \sin\omega_0 t + \frac{A}{2}\sin(\omega_0 - \omega)t + \frac{A}{2}\sin(\omega_0 + \omega)t$$

13. **In the density measurement of a cube, the mass and edge length are measured as $(10.00 \pm 0.10)kg$ and $(0.10 \pm 0.01)m$, respectively. The error in the measurement of density is:**

1. $0.31kg/m^3$ **2.** $0.07kg/m^3$ **3.** $0.01kg/m^3$ **4.** $0.10kg/m^3$

Ans: **1**

Sol: $mass = (10 \pm 0.1)kg$

Length = $(0.1 \pm 0.01)m$

Denisty = $\frac{m}{L^3} = D$

$= \frac{0.1}{10} + 3 \times \frac{0.01}{0.1}$

=0.01+0.3

= 0.31 kg/m^3

14. **A simple pendulum oscillating in air has period T. The bob of the pendulum is completely immersed in a non-viscous liquid. The density of the liquid is $\frac{1}{16}th$ of the material of the bob. If the bob is inside liquid all the time, its period of oscillation in this liquid is:**

1. $2T\sqrt{\frac{1}{10}}$ **2.** $2T\sqrt{\frac{1}{14}}$ **3.** $4T\sqrt{\frac{1}{14}}$ **4.** $4T\sqrt{\frac{1}{15}}$

Ans: **4**

Sol: $T\alpha\sqrt{\frac{1}{g}}$

$\frac{T}{T_1} = \sqrt{\frac{g_1}{g_1}} = \sqrt{\frac{15}{16}}$

$\frac{T}{T'} = \frac{\sqrt{15}}{4}$

$T' = \frac{4T}{\sqrt{15}}$

15. **If 'M' is the mass of water that rises in a capillary tube of radius 'r', then mass of water which will rise in a capillary tube of radius '2r' is:**

1. 4 M **2. M** **3.** $\frac{M}{2}$ **4. 2 M**

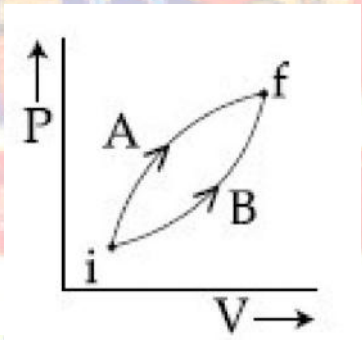
Ans: 4

Sol: $h = \frac{2T}{reg}$ $\quad mass\ \alpha\ r^2h$

$mass\ \alpha\ r$

So final mass rise = 2M

16. **Following figure shows two process A and B for a gas. If** ΔQ_A **and** ΔQ_B **are the amount of heat absorbed by the system in two cases, and** ΔU_A **and** ΔU_B **are changes in internal energies, respectively, then:**



1. $\Delta Q_A > \Delta Q_B, \Delta U_A = \Delta U_B$ **2.** $\Delta Q_A < \Delta Q_B, \Delta U_A < \Delta U_B$

3. $\Delta Q_A > \Delta Q_B, \Delta U_A > \Delta U_B$ **4.** $\Delta Q_A = \Delta Q_B, \Delta U_A = \Delta U_B$

Ans: 1

Sol: $\Delta U_A = \Delta U_B$ **is U is state function**

$\Delta Q_A = \Delta U_A + W_A$

$\Delta Q_B = \Delta U_B + w_B$

$\Delta Q_A - \Delta Q_B = w_A - w_B$

$=> 0$

$\Delta Q_A > \Delta Q_B$

17. **The total number of turns and cross-section area in a solenoid is fixed. However, its length L is varied by adjusting the separation between windings. The inductance of solenoid will be proportional to:**

1. $1/L^2$ **2. L** **3.** L^2 **4. 1/L**

Ans: 4

Sol: WKT

Self inductance $L = \mu n^2 \times (volume)$

$$= \mu \times \frac{N^2}{L^2} \times A \times K$$

$$= \frac{\mu N^2 A}{L}$$

Self inductance $\propto \frac{1}{L}$

18. **A uniform cable of mass 'M' and length 'L' is placed on a horizontal surface such that its** $\left(\frac{1}{n}\right)^{th}$ **part is hanging below the edge of the surface. To lift the hanging part of the cable upto the surface, the work done should be:**

1. $\frac{MgL}{n^2}$ **2.** $nMgL$ **3.** $\frac{MgL}{2n^2}$ **4.** $\frac{2MgL}{n^2}$

Ans: 3

Sol: The resultant is the centre of mass of the part AB is shifter to top i.e. $\Delta h = \frac{l}{2n}$

$$U = mg\,\Delta hcm$$

$$= \frac{M}{L} \times \frac{L}{n} \times g \times \frac{L}{2N} = \frac{MgL}{2n^2}$$

$$U = \frac{MgL}{2n^2}$$

19. **A body of mass 2 kg makes an elastic collision with a second body at rest and continues to move in the original direction but with one fourth of its original speed. What is the mass of the second body?**

1. 1.2 kg **2. 1.8 kg** **3. 1.0 kg** **4. 1.5 kg**

Ans: **1**

Sol: **Momentum conservation**

$$2\times v = 2\times\frac{v}{4}\times m^2 1$$

$$mv_1 = \frac{3v}{2}$$

Elatic collision

Energy conservation

$$\frac{1}{2}\times 2\times v^2 = \frac{1}{2}\times 2\times\left(\frac{v}{4}\right)^2 + \frac{1}{2}mv_1^2$$

$$\frac{2v^2}{16}\times 15 = \frac{(mv_1)^2}{m} \Rightarrow \frac{v^2 15}{8} = \frac{9v^2}{4\times m}$$

$$m = 1.2kg$$

20. **A capacitor with capacitance $5\mu F$ is charged to $5\mu C$. If the plates are pulled apart to reduce the capacitance to $2\mu F$, how much work is done?**

1. $3.75\times10^{-6}J$ **2.** $2.55\times10^{-6}J$ **3.** $6.25\times10^{-6}J$ **4.** $2.16\times10^{-6}J$

Ans: **1**

Sol: $\Rightarrow$ **work done by force** $\Rightarrow$ $F\times S$

$$\Rightarrow \frac{q^2}{2A\in_0}\times\frac{3d}{2}$$

$$\Rightarrow \frac{3q^2\times d}{4\times\in_0 A}$$

$$\Rightarrow \frac{3\times5\times10^{-6}x}{4}$$

$$\Rightarrow 3.75\times10^{-6}J$$

21. **A rectangular coil (Dimension $5cm \times 2.5cm$) with 100 turns, carrying a current of 3A in the clock-wise direction, is kept centered at the origin and in the X-Z plane. A magnetic field of 1 T is applied along X-axis. If the coil is tilted through 45° about Z-axis, then the torque on the coil is**

1. 0.38 Nm **2. 0.42 Nm** **3. 0.55 Nm** **4. 0.27 Nm**

Ans: **4**

Sol: **Torque** $= M \times B$

$= Nxi \times A \times B \times \sin 4J$

$= 100 \times 3 \times 12.5 \times 10^{-4} \times 1 \times 1\frac{1}{\sqrt{2}}$

$\tau = 0.265$

22. **The figure shows a Young's double slit experimental setup. It is observed that when a thin transparent sheet of thickness t and refractive index μ is put in front of one of the slits, the central maximum gets shifted by a distance equal to n fringe widths. If the wavelength of light used is λ, t will be:**

1. $\frac{2nD\lambda}{a(\mu-1)}$ **2.** $\frac{2D\lambda}{a(\mu-1)}$ **3.** $\frac{nD\lambda}{a(\mu-1)}$ **4.** $\frac{D\lambda}{a(\mu-1)}$

Ans: **3**

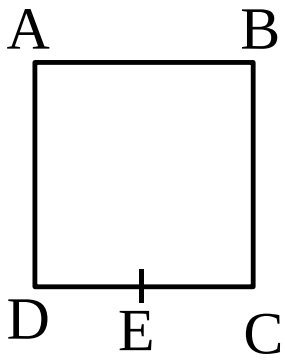
Sol: $S_1P - S_2P + (\mu-1)t = 0$

$(\mu-1)t = S_2P - S_1P$

$(\mu-1)t = nl$

$t = \frac{nl}{\mu-1}$

23. **A wire of resistance R is bent to form a square ABCD as shown in the figure. The effective resistance between E and C is: (E is mid-point of arm CD)**



1. R **2.** $\frac{3}{4}R$ **3.** $\frac{7}{64}R$ **4.** $\frac{1}{16}R$

Ans: 3

Sol: $R_{AB}=\frac{R}{4}$ $R_{AD}=\frac{R}{4}$ $R_{BC}=\frac{R}{4}$ $RO_{\in}=R_{\in C}=\frac{R}{8}$

$$\text{Reff}=\frac{\left(\frac{R}{4}+\frac{R}{4}+\frac{R}{4}+\frac{R}{8}\right)}{\frac{R}{4}+\frac{R}{4}+\frac{R}{4}+\frac{R}{8}}$$

$$=\frac{\left(\frac{7R}{8}\right)\left(\frac{R}{8}\right)}{R}=\frac{7R}{64}$$

24. A rigid square loop of side 'a' and carrying current I_2 is lying on a horizontal surface near a long current I_1 carrying wire in the same plane as shown in figure. The net force on the loop due to the wire will be:

1. Attractive and equal to $\frac{\mu_0 I_1 I_2}{3\pi}$ **2. Zero**

3. Repulsive and equal to $\frac{\mu_0 I_1 I_2}{4\pi}$ **4. Repulsive and equal to** $\frac{\mu_0 I_1 I_2}{2\pi}$

Ans: 3

Sol: $\overline{F_{AB}}+\overline{F_{DC}}=0$

$F_{AD}=BI_2a$

$=\frac{\mu_0 I}{2\pi(\alpha)}I_2(\alpha)$ **(right wards)**

$= \frac{\mu I_1 I_2}{2\pi}$

$F_{BC} = B' I_2 a$

$= \frac{\mu_0 I_1 I_2}{4\pi}$ **(up + wards)**

$F_{net} = \frac{\mu_0 I_1 I_2}{2\pi} - \frac{\mu_0 I_1 I_2}{4\pi}$

$= \frac{\mu_0 I_1 I_2}{4\pi}$ **(right wards ev (repulsive)**

25. The stream of a river is flowing with a speed of 2 km/h. A swimmer can swim at a speed of 4 km/h. What should be the direction of the swimmer with respect to the flow of the river to cross the river straight?

1. 150º **2. 60º** **3. 90º** **4. 120º**

Ans: 4

Sol: to cross the river straight, $V_{\text{along the river}} = 0$

$V_{steam} = V_{swimmer} \cos\theta$

$2 = 4\cos\theta \Rightarrow \cos\theta = \frac{1}{2}$

$\Rightarrow \theta = 60^\circ$

Direction w.r.t flow of river = 180º-60º = 120º

26. A stationary horizontal disc is free to rotate about its axis. When a torque is applied on it, its kinetic energy as a function of θ, where θ is the angle by which it has rotated, is given as $k\theta^2$. If its moment of inertia is I then the angular acceleration of the disc is:

1. $\frac{2k}{I}\theta$ **2.** $\frac{k}{2I}\theta$ **3.** $\frac{k}{4I}\theta$ **4.** $\frac{k}{I}\theta$

Ans: 1

Sol: $KE = K\theta^2$

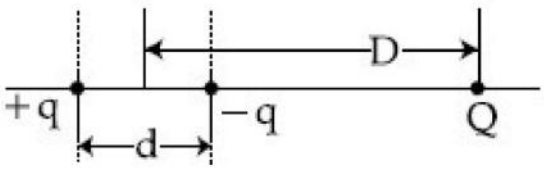
$\Rightarrow \frac{1}{2} I W^2 = K\theta$

Differentiating on both sides w.r.t to θ

$$\frac{1}{2}I\frac{d}{d_\theta}\left(\omega^2\right)=k\frac{d}{d\theta}\left(\theta^2\right)$$

$$I\alpha=2\theta(K)\Rightarrow\alpha=\frac{2k}{I}=\theta$$

27. **A system of three charges are placed as shown in the figure:**



If D > > d, the potential energy of the system is best given by:

1. $\frac{1}{4\pi\varepsilon_0}\left[+\frac{q^2}{d}+\frac{qQd}{D^2}\right]$ **2.** $\frac{1}{4\pi\varepsilon_0}\left[-\frac{q^2}{d}-\frac{qQd}{2D^2}\right]$

3. $\frac{1}{4\pi\varepsilon_0}\left[-\frac{q^2}{d}+\frac{2qQd}{D^2}\right]$ **4.** $\frac{1}{4\pi\varepsilon_0}\left[-\frac{q^2}{d}-\frac{qQd}{D^2}\right]$

Ans: **4**

Sol: **The potential energy of +q, -q system is** $U_1=\frac{-kq^2}{d}$

The system of +q, -q act as an electric dipole as d<<D

Hence, Potential energy between Q and dipole is $U_2=\frac{-kp}{r^2}Q$

Hence, $U=U_1+U_2=\frac{+1}{4\pi\varepsilon_0}\left[\frac{-q^2}{d}-\frac{d\theta d}{D^2}\right]$

28. **An HCl molecule has rotational, translational and vibrational motions. If the rms velocity of HCl molecules in its gaseous phase is** $\vec{v}$**, m is its mass and** k_B **is Boltzman constant, then its temperature will be :**

1. $\frac{mv^{-2}}{6k_B}$ **2.** $\frac{mv^{-2}}{7k_B}$ **3.** $\frac{mv^{-2}}{3k_B}$ **4.** $\frac{mv^{-2}}{5k_B}$

Ans: **1**

Sol: $V_{rms}=\sqrt{\frac{3KT}{m}}\Rightarrow V^{-2}=\frac{3KT}{m}\,T=\frac{mv^{-2}}{3k}$

29. **A concave mirror for face viewing has focal length of 0.4 m. The distance at which you hold the mirror from your face in order to see your image upright with a magnification of 5 is:**

1. 0.24 m **2. 0.16 m** **3. 1.60 m** **4. 0.32 m**

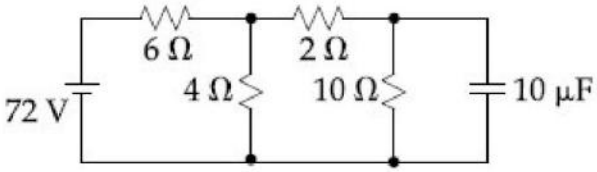
Ans: 4

Sol: $\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$ $\frac{1}{u}=\frac{1}{v}+\frac{1}{0.4}$

$m=\frac{v}{u}=5$ $v=-54$

$\frac{1}{u}-\frac{1}{5u}=\frac{1}{0.4}\ u=\frac{1.6}{5}=0.32$

30. **Determine the charge on the capacitor in the following circuit:**



1. $10\mu C$ **2.** $200\mu C$ **3.** $60\mu C$ **4.** $2\mu C$

Ans: 2

Sol: $R_T=\frac{4\times12}{16}+6 \quad =9\Omega$

$I_T=\frac{72}{9}=8A$

$I_{12}=8\times\frac{4}{16}=2A$

$I_{10}=2A$

$V_{10}=20V$

$V_C=20V\Rightarrow Q_C=20\times10\mu F=200\mu F$

CHEMISTRY

31. Among the following, the set of parameters that represents path functions, is:

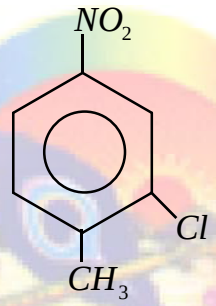
A) q+w **B) q** **C) w** **D) H-TS**

1. A, B and C **2. B, C and D** **3. B and C** **4. A and D**

Ans: 3

Sol: Except q, w all other thermodynamic variables are state functions q, w are path functions.

32. The correct IUPAC name of following compound is



1. 2-methyl – 5 - nitro 1- chlorobenzene

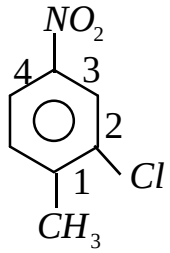
2. 2-+chloro – 1- methyl -4 - nitrobenzene

3. 5 – chloro – 4 – methyl – 1 – nitrobenzene

4. 3- chloro – 4 – methyl – 1 – nitrobenzene

Ans: 2

Sol:



NO_2 **- Nitro** **C*l* - Chloro** CH_3 **- Methyl**

33. The degenerate orbitals of $\left[Cr\left(H_2O\right)_6\right]^{3+}$ **are**

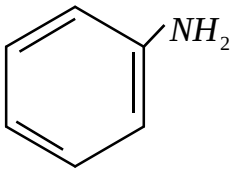
1. d_{yz} **and** $d_z 2$ **2.** $d_x 2$ and d_{xz} **3.** d_{xz} and d_{yz} **4.** $d_{x^2-y^2}$ and d_{xy}

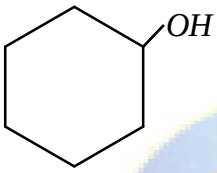
Ans: 3

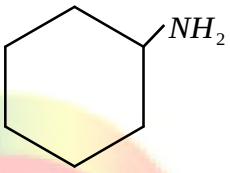
Sol: d_{zx}, d_{yz} are degenerate in octahedral splitting.

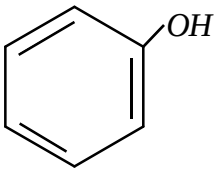
34. The organic compound that gives following qualitative analysis is:

Test	Inference
a) Dil. HCl	Insoluble
b) NaOH solution	Soluble
c) Br_2/ water	Decolourization

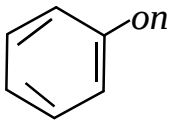
1. 

2. 

3. 

4. 

Ans: 3

Sol: 

insoluble in Dil. HCl, Soluble in NaOH solution , & Decolourization of Br_2 / water

35. Excessive release of CO_2 into the atmosphere results in

1. depletion of ozone
2. polar vertex
3. formation of smog
4. global warming

Ans: 4

Sol: Excessive release of CO_2 into the atmosphere results in global warming.

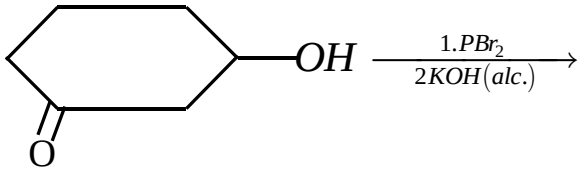
36. The element having greatest difference between its first and second ionization energies, is

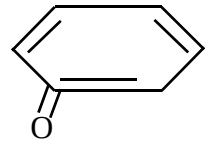
1. K
2. Ca
3. Ba
4. Sc

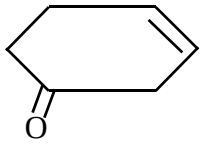
Ans: 1

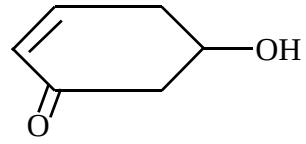
Sol: In given options k has greatest difference between its first & second ionisation energies.

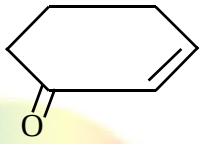
37. The major product of the following reaction is:



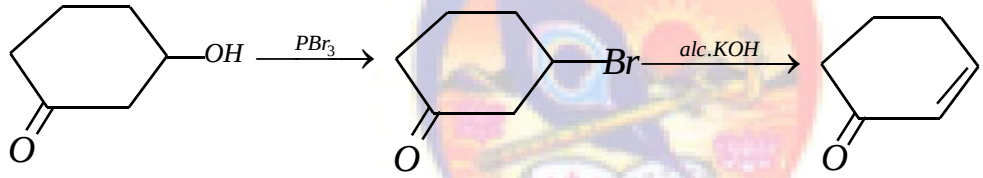
1. 

2. 

3. 

4. 

Ans: 4

Sol: 

38. The number of water molecules not coordinated to copper ion directly in $CuSOl4.5H_2O$, is

1. 2 **2. 3** **3. 1** **4. 4**

Ans: 3

Sol: In $CnSO_4.5H_2O$, four water molecules are coordinates to Cu^{2+} ion and one water molecules is outside the coordinate sphere.

Number of water molecules not coordinated to copper ion is

39. C_{60}, an allotrope of carbon contains:

1. 18 hexagons and 14 pentagons **2. 20 hexagons and 12 pentagons**

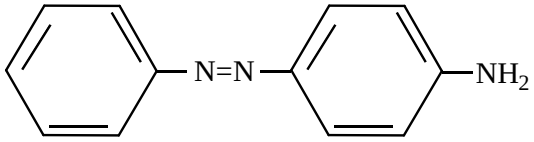
3. 12 hexagons and 20 pentagons **4. 16 hexagons and 16 pentagons**

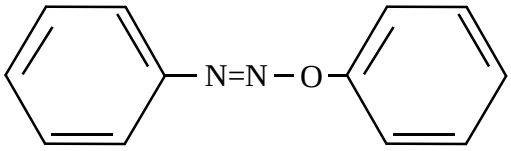
Ans: 2

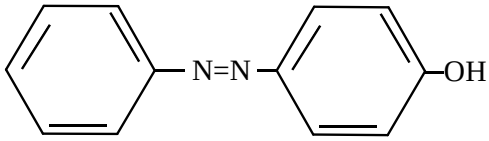
Sol: In C_{60}, $\frac{n}{2}-10$ hexagonal, 12 pentagonal

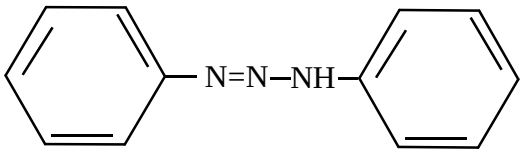
$\Rightarrow$ 20 hexagonal, 12 petagonal

40. Aniline dissolved in dilute HCl is reacted with sodium nitrite at 0°C. this solution was added dropwise to a solution containing equimolar mixture of aniline and phenol in dil. HCl. The structure of the major product is

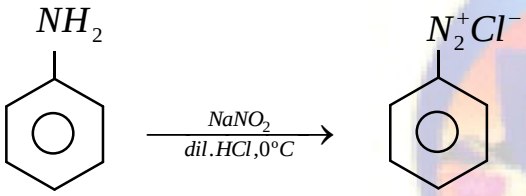
1. 

2. 

3. 

4. 

Ans: 1

Sol: 

In equimolar mixture of aniline, phenol in dil.HCl, amiline in more reactive, as slightly acidic medium supports.

41. The major product of the following reaction is $Ch_3C \equiv CH \xrightarrow[(ii)Dl]{(i)DCl(1equiv.)}$

1. $CH_3C(l)(Cl)CHD_2$ **2.** $CH_3CD(Cl)CHD(l)$

3. $CH_3CD_2CH(Cl)(l)$ **4.** $CH_3CD(l)CHD(Cl)$

Ans: 1

Sol: $CH_3C \equiv C-H \xrightarrow[(ii)\ DI]{(i)\ DCl(eqilateralent)}$ $CH_3-\underset{Cl}{\overset{I}{C}}-\underset{D}{\overset{D}{C}}-H$

42. The standard Gibbs energy for the given cell reaction in kJ mol^{-1} at 298 K is:

$Zn(s)+Cu^{2+}(aq) \rightarrow Zn^{2+}(aq)+Cu(s), E^{o}=2V\ at\ 298K$

1. -192 **2. 384** **3. -384** **4.192**

Ans: 3

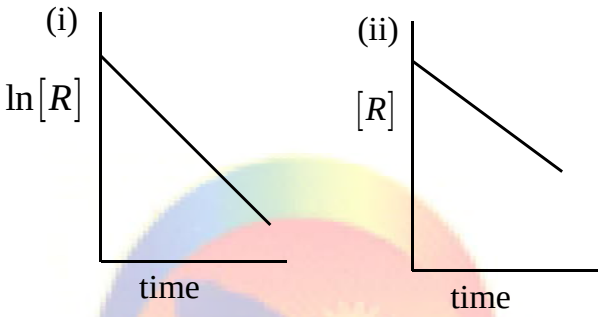
Sol: $Zn(s)+Cu^{+2}(aq) \longrightarrow Zn^{+2}_{(aq)}+Cu(s)$

$\Delta G^o = -nFE^0_{cell}$

$= -2 \times 96000 \times 2$

$= -4 \times 96kJ \ = -384kJ$

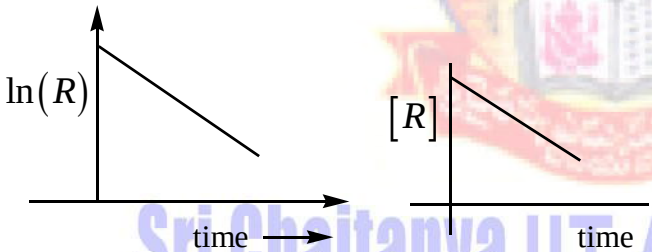
43. The given plots represent the variation of the concentration of a reactant R with time for two different reactions (i) and (ii). The respective orders of the reactions are



1. 0,1 **2. 0,2** **3. 1,0** **4. 1,1**

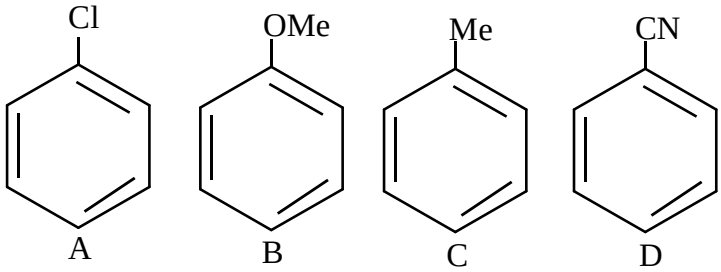
Ans: 3

Sol:



T is proportional [R] it is 1st order t is proportional to [R] it is 0th order

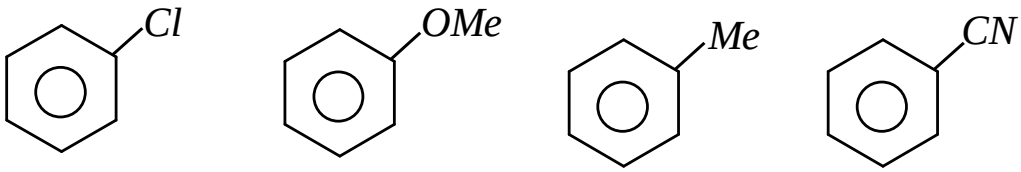
44. The increasing order of reactivity of the following compounds towards aromatic electrophilic substitution reaction is



1. D<A<C<B **2. B<C<A<D** **3. D<B<A<C** **4. A<B<C<D**

Ans: 1

Sol:



B > C > A > D(dueto + M, Directing)

45. **The correct order of the oxidation states of nitrogen in** NO, N_2O, NO_2 *and* N_2O_3 **is**

1. $NO_2 < NO < N_2O_3 < N_2O$ **2.** $N_2O < N_2O_3 < NO < NO_2$

3. $N_2O < NO < N_2O_3 < NO_2$ **4.** $NO_2 < N_2O_3 < NO < N_2O$

Ans: 3

Sol:

Compound	**Oridation state**
No	**+2**
N_2O	**+1**
NO_2	**+4**
N_2O_3	**+3**

46. **Match the catalysts (colum I) with products (column II).**

Column I	**Column II**
Catalyst	**Product**
A) V_2O_5	**i) Polyethylene**
B) $TiCl_4 / Al(Me)_3$	**ii) ethanal**
C) $PdCl_2$	**iii)** H_2SO_4
D) Iron oxide	**iv)** NH_3

1. a-iii, b-i, c-ii, d-iv **2. a-ii, b-iii, c-i, d-iv**

3. a-iv, b-iii, c-ii, d-i **4. a-iii, b-iv, c-i, d-ii**

Ans: 1

Sol:

Catalyst	**Product**
V_2O_5	H_2SO_4
$TiCl_4 / Al(Me)_3$	**Polyethelene**
$PdCl_2$	**Ethanal**
Iron oxide	NH_3

47. **Which of the following statement is not true about sucrose?**

1. On hydrolysis, it produces glucose and fructose

2. It is also named as invert sugar

3. It is non-reducing sugar

4. The glycosidic linkage is present between C_1 of $\alpha-$ glucose and C_1 of $\beta-$ fructose

Ans: **4**

Sol: $Sucrose \xrightarrow{hydrolysis} glu\cos e + fructose$

48. **The aerosol is a kind of colloid in which:**

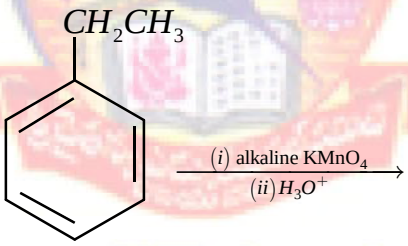
1. Solid is dispersed in gas **2. liquid is dispersed in water**

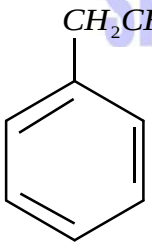
3. gas is dispersed in liquid **4. gas is dispersed in solid**

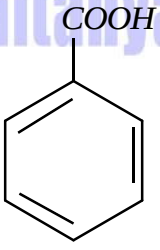
Ans: **1**

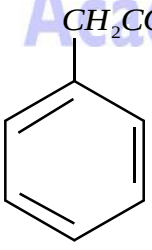
Sol: **aerosol is a kind of colloid is disersion phase$_{(s)}$ dispersion medium$_{(g)}$**

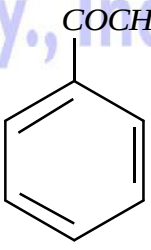
49. **The major product of the following reaction is**



1. 

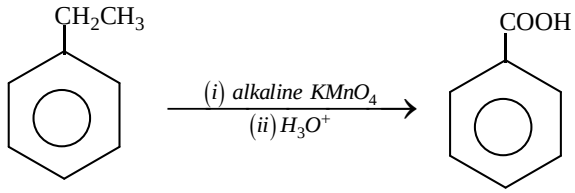
2. 

3. 

4. 

Ans: **2**

Sol:



50. **Consider the van der walls constants, a and b, for the following gases**

Gas	*Ar*	*Ne*	*Kr*	*Xe*
$a/\left(atm\,dm^6 mol^{-2}\right)$	1.3	0.2	5.1	4.1
$b/\left(10^{-2}\,dm^3 mol^{-1}\right)$	3.2	1.7	1.0	5.0

Which gas is expected to have the highest critical temperature

1. Kr **2. Ar** **3. Ne** **4. Xe**

Ans: **1**

Sol: **To have highest critical temperature a should be high b should below so, it is Kr**

51. **Among the following, the molecule expected to be stabilized by anion formation is:**

C_2, O_2, NO, F_2

1. NO **2.** C_2 **3.** F_2 **4.** O_2

Ans: **2**

Sol: **C_2 has vacant and if e^- enters into this if will be stabilized**

52. **The ore that contains the metal in the form of fluoride is**

1. cryolite **2. Malachite** **3. Magnetite** **4. Sphalerite**

Ans: **1**

Sol: **Cryolife $\rightarrow Na_3AlF_6$**

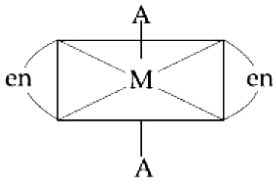
Malachite $\rightarrow CuCO_3.CU(OH)_2$

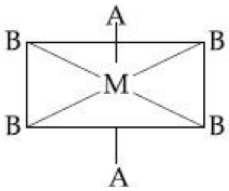
Magnetite $\rightarrow Fe_3O_4$

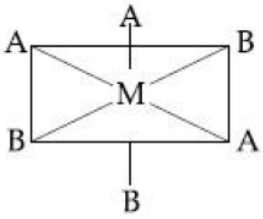
Sphalarite $\rightarrow ZnS$

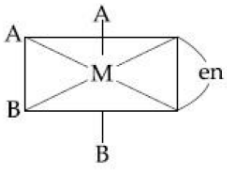
53. **The one that will show optical activity is:**

(en = ethane – 1,2, -diamine)

1. 

2. 

3. 

4. 

Ans: **4**

Sol: **Given which will show optical activity**

The Compound should not have plans of symmetry only compounds in options

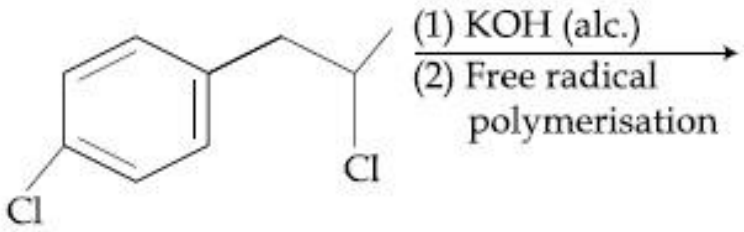
54. **For any given series of spectral lines of atomic hydrogen, let $\Delta\bar{v} = \bar{v}_{max} - \bar{v}_{min}$ be the difference in maximum and minimum frequencies in cm^{-1}. The ratio $\Delta\bar{v}_{balmer}$ is:**

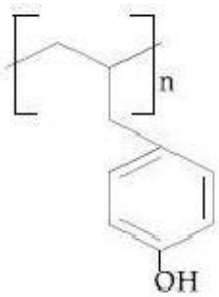
1. 4:1 **2. 9:4** **3. 5:4** **4. 27.5**

Ans: **2**

Sol: $$\frac{\Delta\bar{V}_{vyman}}{\Delta\bar{V}_{Balmer}} = \frac{R\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right] - R\left[\frac{1}{1^2} - \frac{1}{2^2}\right]}{R\left[\frac{1}{2^2} - \frac{1}{\infty^2}\right] - R\left[\frac{1}{2^2} - \frac{1}{3^2}\right]} = \frac{9}{4}$$

55. **The major product of the following reaction is:**



1.


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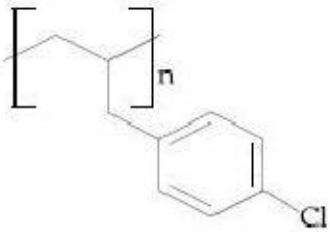

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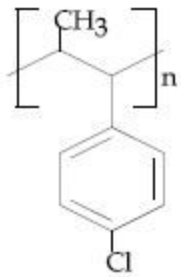

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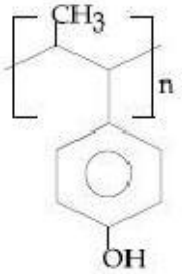


Ans: **3**

Sol:

56. **The osmotic pressure of a dilute solution of an ionic compound XY in water is four times that of a solution of 0.01 M $BaCl_2$ in water. Assuming complete dissociation of the given ionic compounds is water, the concentration of XY (in mol L^{-1}) in solution is**

1. 4×10^{-4} **2.** 16×10^{-4} **3.** 4×10^{-2} **4.** 6×10^{-2}

Ans: **4**

Sol: **2 – Chloro – 1 – methyl - 4 – nitro benzene**

$$2 \times C \times RT = \left(3 \times \underbrace{0.01}_{\text{for } BaCl_2} \times RT\right) \times 4$$

i-factor for xy

C = 0.06 M

57. **For a reaction, $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$: identify dihydrogen (H_2) as a limiting reagent in the following reaction mixtures.**

1. 35g of N_2 + 8g of H_2 **2. 28g of N_2+6g of H_2**

3. 56g of N_2 + 10g of H_2 **4. 14g of N_2+ 4g of H_2**

Ans: 3

Sol: $N_2 + 3H_2 \rightarrow 2NH_3$

56g 10 g

2 mol 5 mol

Actually 6 mol of H_2 is required but only 5 mol present so it is limiting reagent.

58. **Magnesium powder burns in air to give:**

1. $Mg(NO_3)_2$ and Mg_3N_2 **2.** MgO and Mg_3N_2

3. MgO **only** **4.** MgO and $Mg(NO_3)_2$

Ans: 2

Sol: $Mh + O_2 \rightarrow MgO + Mg_3N_2$

59. **The major product of the following reaction is**

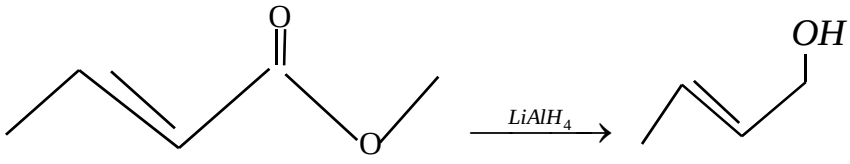
$$CH_3CH = CHCO_2CH_3 \xrightarrow{LiAlH_4}$$

1. $CH_3CH_2CH_2CO_2CH_3$ **2.** $CH_3CH_2CH_2CH_2OH$

3. $CH_3CH_2CH_2CHO$ **4.** $CH_3CH = CHCH_2OH$

Ans: 4

Sol:



60. **Liquid 'M' and liquid 'N' form an ideal solution. The vapour pressures of pure liquids 'M' and 'N' are 450 and 700mmHg, respectively, at the same temperature. Then correct statement is:**

(x_M = Mole fraction of 'M' is solution;
x_N = Mole fraction of 'N' in solution ;
y_M = Mole fraction of 'M' in vapour phase;
y_N = Mole fraction of 'N' in vapour phase)

1. $\frac{x_M}{x_N} < \frac{y_M}{y_N}$ **2.** $\frac{x_M}{x_N} = \frac{y_M}{y_N}$ **3.** $\frac{x_M}{x_N} > \frac{y_M}{y_N}$ **4.** $(x_M - y_M) < (x_N - y_N)$

Ans: 3

Sol: $PM^0 = 450$

$PN^0 = 700$ $\quad \frac{y_M}{y_N} = \frac{x_m}{x_n}\left(\frac{450}{700}\right)$

$y_m = \frac{P_M{}^0 X_m}{P_t}$ $\quad \frac{X_m}{X_n}.\left(\frac{Y_N}{Y_M}\right) > 1$

$Y_N = \frac{PN^0 X_n}{Pt}$ $\quad \frac{X_m}{X_n} > \frac{Y_m}{Y_n}$

MATHS

61. **Let** $S=\{\theta\in[-2\pi,2\pi]: 2\cos^2\theta+3\sin\theta=0\}$. **Then the sum of the elements of S is:**

1. $\frac{5\pi}{3}$ **2.** 2π **3.** $\frac{13\pi}{6}$ **4.** π

Ans: 2

Sol: **solving the trigonometric equation, we get** $\sin\theta=\frac{-1}{2}$

$\theta\in[-2\pi,2\pi]$ **so** $\theta=\frac{-\pi}{6},\frac{-5\pi}{6},\frac{7\pi}{6},\frac{11\pi}{6}$ **so** $\text{sum}=2\pi$

62. **If the standard deviation of the numbers** $-1,0,1,k$ **is** $\sqrt{5}$ **where** $k>0$**, then k is equal to:**

1. $2\sqrt{\frac{10}{3}}$ **2.** $2\sqrt{6}$ **3.** $4\sqrt{\frac{5}{3}}$ **4.** $\sqrt{6}$

Ans: 2

Sol: $\sigma^2=\frac{\sum x_i^2}{n}-\left(\frac{\sum x_i}{n}\right)^2\Rightarrow 5=\frac{k^2+2}{4}-\frac{k^2}{16}\Rightarrow k=2\sqrt{6}$

63. **All the points in the set** $S=\left\{\frac{\alpha+i}{\alpha-i}:\alpha\in R\right\}\left(i=\sqrt{-1}\right)$ **lie on a:**

1. circle whose radius is $\sqrt{2}$ **2. circle whose radius is 1**

3. straight line whose slope is -1 **4. straight line whose slope is 1**

Ans: 2

Sol: $x+iy=\frac{(\alpha+i)^2}{\alpha^2+1}\Rightarrow x=\frac{\alpha^2-1}{\alpha^2+1},y=\frac{2\alpha}{\alpha^2+1}$

So $x^2+y^2=1$**, is a circle of radius 1**

64. **For any two statements p and q, the negation of the expression** $p\vee(\sim p\wedge q)$ **is:**

1. $p\wedge q$ **2.** $\sim p\wedge\sim q$ **3.** $p\leftrightarrow q$ **4.** $\sim p\vee\sim q$

Ans: 2

Sol: $p \vee (\sim p \wedge q) = (p \vee \sim p) \wedge (p \vee q) = T \wedge (p \vee q) = p \vee q$

So $\sim (p \vee (\sim p \wedge q)) = \sim (p \vee q) = \sim p \wedge \sim q$ **(or) draw truth tables**

65. **If the function** $f : R - \{1,-1\} \to A$ **defined by** $f(x) = \frac{x^2}{1-x^2}$**, is surjective, then A is equal to:**

1. $R - (-1,0)$ **2.** $R - [-1,0)$ **3.** $R - \{-1\}$ **4.** $[0,\infty)$

Ans: 2

Sol: **Let** $y = \frac{x^2}{1-x^2} \Rightarrow y - x^2 y = x^2$

$x^2 (1+y) = y$

$x^2 = \frac{y}{1+y} \geq 0 (y \neq -1)$

$y(y+1) \geq 0 \Rightarrow y \in (-\infty,-1) \cup [0,\infty)$

So $A = R - [-1,0)$

66. **If the fourth term in the Binomial expansion of** $\left(\frac{2}{x} + x^{\log_g x}\right)^6 (x > 0)$ **is** 20×8^7**, then a value of x is:**

1. 8^2 **2. 8** **3.** 8^3 **4.** 8^{-2}

Ans: 1

Sol: **equate** $T_4 = 20 \times 8^7$

$\Rightarrow {}^6C_3 \cdot \left(\frac{2}{x}\right)^3 \cdot \left(x^{\log_8^x}\right)^3 = 20 \times 8^7$

Take logaritham on both side to base 8, we get

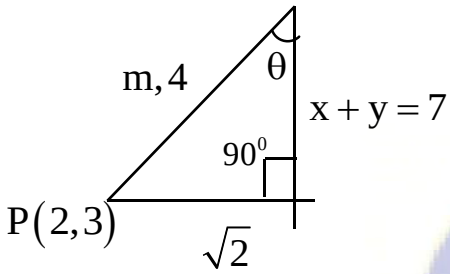
$\left(\log_8^x\right)^2 = 2 + \left(\log_8^x\right) \Rightarrow \log_8^x = 2$ **(or)** $-1 \Rightarrow x = 8^2$ **(or)** $\frac{1}{8}$

67. **Slope of a line passing through $P(2,3)$ and intersecting the line, $x+y=7$ at a distance of 4 units from P, is:**

1. $\frac{1-\sqrt{5}}{1+\sqrt{5}}$ **2.** $\frac{1-\sqrt{7}}{1+\sqrt{7}}$ **3.** $\frac{\sqrt{7}-1}{\sqrt{7}+1}$ **4.** $\frac{\sqrt{5}-1}{\sqrt{5}+1}$

Ans: **2**

Sol:



$$\tan\theta=\frac{\sqrt{2}}{\sqrt{14}}=\frac{1}{\sqrt{7}}=\left|\frac{m+1}{1+m(-1)}\right|=\left|\frac{m+1}{1-m}\right|$$

$\frac{m+1}{1-m}=\pm\frac{1}{\sqrt{7}}\Rightarrow$ **simplify get** $m=\frac{1-\sqrt{7}}{1+\sqrt{7}}$ **(or)** $m=\frac{1+\sqrt{7}}{1-\sqrt{7}}$

68. **If $f(x)$ is a non-zero polynomial of degree four, having local extreme points at $x=-1,0,1$; Then the set $S=\{x\in R: f(x)=f(0)\}$ contains exactly:**

1. four irrational numbers

2. two irrational and two rational numbers

3. two irrational and one rational number

4. four rational numbers

Ans: **3**

Sol: **Let** $f^1(x)=\lambda(x)(x^2-1)\Rightarrow f(x)=\lambda\left(\frac{x^4}{4}-\frac{x^2}{2}\right)+c$

$$f(0)=f(x)\Rightarrow \cancel{c}=\lambda\left(\frac{x^4}{4}-\frac{x^2}{2}\right)+\cancel{c}$$

$\Rightarrow \frac{x^2}{2}\left(\frac{x^2}{2}-1\right)=0\ x=0$ **(or)** $x=\pm\sqrt{2}$

69. **Let** $\vec{\alpha}=3\hat{i}+\hat{j}$ **and** $\vec{\beta}=2\hat{i}-\hat{j}+3\hat{k}$**. If** $\vec{\beta}=\vec{\beta_1}-\vec{\beta_2}$**, where** $\vec{\beta_1}$ **is parallel to** $\vec{\alpha}$ **and** $\vec{\beta_2}$ **is perpendicular to** $\vec{\alpha}$**, then** $\vec{\beta_1}\times\vec{\beta_2}$ **is equal to:**

1. $\frac{1}{2}\left(-3\hat{i}+9\hat{j}+5\hat{k}\right)$ **2.** $\frac{1}{2}\left(3\hat{i}-9\hat{j}+5\hat{k}\right)$

3. $3\hat{i}-9\hat{j}-5\hat{k}$ **4.** $-3\hat{i}+9\hat{j}+5\hat{k}$

Ans: 1

Sol: **Let** $\overline{\beta_1}=k_1\overline{\alpha}$, $\overline{\beta_2}=k_2\left(\bar{i}-3\bar{j}+\lambda\bar{k}\right)$

Given $\overline{\beta}=\overline{\beta_1}-\overline{\beta_2}\Rightarrow$ **equating** $\bar{i},\bar{j},\bar{k}$ **coefficient we get** $k_1=\frac{1}{2},k_2=\frac{-1}{2}$ **find**

$\overline{\beta_1}\times\overline{\beta_2}=\frac{1}{2}\left(-3\bar{i}+9\bar{j}+5\bar{k}\right)$

70. **If the function f defined on** $\left(\frac{\pi}{6},\frac{\pi}{3}\right)$ **by** $f(x)=\begin{cases}\frac{\sqrt{2}\cos x-1}{\cot x-1}, & x\neq\frac{\pi}{4}\\ k, & x=\frac{\pi}{4}\end{cases}$ **is continuous, then k is equal to:**

1. 2 **2.** $\frac{1}{2}$ **3.** $\frac{1}{\sqrt{2}}$ **4.** 1

Ans: 2

Sol: $k=\underset{x\to\frac{\pi}{4}}{Lt}\frac{\sqrt{2}\cos x-1}{\cot\alpha-1}\left(\frac{0}{0}\text{ form}\right)$ **by LH rule we get** $k=\frac{1}{2}$

71. **Let** α **and** β **be the roots of the equation** $x^2+x+1=0$**. Then for** $y\neq 0$ **in R,**

$\begin{vmatrix} y+1 & \alpha & \beta \\ \alpha & y+\beta & 1 \\ \beta & 1 & y+\alpha \end{vmatrix}$ **is equal to:**

1. $y\left(y^2-1\right)$ **2.** y^3 **3.** $y\left(y^2-3\right)$ **4.** y^3-1

Ans: 2

Sol: $\alpha+\beta=-1, \alpha\beta=1, \alpha^2+\beta^2=-1$

$R_1 \to R_1+R_2+R_3$ **& take common** $(y+1+\alpha+\beta)$

Given determinant $=(y+1+(-1))\begin{vmatrix}1 & 1 & 1\\ \alpha & y+\beta & 1\\ \beta & 1 & y+\alpha\end{vmatrix}$ **expanding simplify**

$=y(y^2)=y^3$

72. If the line $y=mx+7\sqrt{3}$ **is normal to the hyperbola** $\frac{x^2}{24}-\frac{y^2}{18}=1$**, then a value of m is:**

1. $\frac{\sqrt{5}}{2}$ **2.** $\frac{\sqrt{15}}{2}$ **3.** $\frac{2}{\sqrt{5}}$ **4.** $\frac{3}{\sqrt{5}}$

Ans: 3

Sol: use $\frac{a^2}{\ell^2}-\frac{b^2}{m^2}=\frac{(a^2+b^2)^2}{n^2}$ **here** $a^2=24, b^2=18, \ell=m, m=-1, n=7\sqrt{3}$

Simplify we get $m=\frac{2}{\sqrt{5}}$

73. The value of $\int_0^{\pi/2}\frac{\sin^3 x}{\sin x+\cos x}dx$ **is:**

1. $\frac{\pi-2}{4}$ **2.** $\frac{\pi-2}{8}$ **3.** $\frac{\pi-1}{4}$ **4.** $\frac{\pi-1}{2}$

Ans: 3

Sol: use $\int_0^a f(x)dx=\int_0^a f(a-x)dx$

Simplify we get, given integral $=\frac{\pi-1}{4}$

74 **If the line, $\frac{x-1}{2}=\frac{y+1}{3}=\frac{z-2}{4}$ meets the plane, $x+2y+3z=15$ at a point P, then the distance of P from the origin is:**

1. $\frac{\sqrt{5}}{2}$ **2.** $2\sqrt{5}$ **3.** $\frac{9}{2}$ **4.** $\frac{7}{2}$

Ans: 3

Sol: **Let** $P(2t+1,3t-1,4t+2)$ **be any point on the line, P lies on plane also**

$\Rightarrow t=\frac{1}{2}, P\left(2,\frac{1}{2},4\right), OP=\frac{9}{2}$

75. **Let** $\sum_{k=1}^{10} f(a+k)=16\left(2^{10}-1\right)$**, where the function f satisfies** $f(x+y)=f(x)f(y)$ **for all natural numbers x, y and** $f(1)=2$**. Then the natural number 'a' is**

1. 16 **2. 2** **3. 3** **4. 4**

Ans: 3

Sol: $f(x)=2^x$ **& simplify (using G.P formula) we get** $a=3$

76. **If one end of a focal chord of the parabola,** $y^2=16x$ **is at** $(1,4)$**, then the length of this focal chord is:**

1. 24 **2. 22** **3. 20** **4. 25**

Ans: 4

Sol: **use** $t_1t_2=-1, t_1=\frac{1}{2}, t_2=-2$

So $Q(16,-16), (P(1,4)$ given$)$ $PQ=25$

77. **The solution of the differential equation** $x\frac{dy}{dx}+2y=x^2, (x\neq 0)$ **with** $y(1)=1$**, is:**

1. $y=\frac{4}{5}x^3+\frac{1}{5x^2}$ **2.** $y=\frac{3}{4}x^2+\frac{1}{4x^2}$ **3.** $y=\frac{x^2}{4}+\frac{3}{4x^2}$ **4.** $y=\frac{x^3}{5}+\frac{1}{5x^2}$

Ans: 3

Sol: **LDE** $IF = e^{\int \frac{2}{x} dx} = x^2$

$$y.x^2 = \int x.x^2 dx = \frac{x^4}{4} + c, c = \frac{3}{4}$$

$$y = \frac{x^2}{4} + \frac{3}{4x^2}$$

78. **If the tangent to the curve,** $y = x^3 + ax - b$ **at the point** $(1,-5)$ **is perpendicular to the line,** $-x + y + 4 = 0$**, then which one of the following points lies on the curve?**

1. $(2,-1)$ **2.** $(-2,2)$ **3.** $(2,-2)$ **4.** $(-2,1)$

Ans: **3**

Sol: $f(1) = -5 \Rightarrow 1 + a - b = -5 \Rightarrow a - b = -6$ **.....(1)**

$f^1(x) = 3x^2 + a \quad f^1(1) = 3 + a = -1 \Rightarrow a = -4$

$b = a + 6 = 2$

$f(x) = x^3 - 4x - 2$ **check options** $((2,-2)\text{satisfies})$

79. **If** $\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 3 \\ 0 & 1 \end{bmatrix}.....\begin{bmatrix} 1 & n-1 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 78 \\ 0 & 1 \end{bmatrix}$ **then the inverse of** $\begin{bmatrix} 1 & n \\ 0 & 1 \end{bmatrix}$ **is**

1. $\begin{bmatrix} 1 & -12 \\ 0 & 1 \end{bmatrix}$ **2.** $\begin{bmatrix} 1 & 0 \\ 12 & 1 \end{bmatrix}$ **3.** $\begin{bmatrix} 1 & 0 \\ 13 & 1 \end{bmatrix}$ **4.** $\begin{bmatrix} 1 & -13 \\ 0 & 1 \end{bmatrix}$

Ans: **4**

Sol: $\begin{bmatrix} 1 & 78 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 1+2+3...+(n-1) \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & \frac{(n-1)n}{2} \\ 0 & 1 \end{bmatrix}$

$(n-1)n = 156 = 13 \times 2 \Rightarrow n = 13 (n \in N)$

So increase of $\begin{bmatrix} 1 & 13 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & -13 \\ 0 & 1 \end{bmatrix}$

80. **The value of is** $\cos^2 10^0 - \cos 10^0 \cos 50^0 + \cos^2 50^0$ **is :**

1. $\frac{3}{4}$ **2.** $\frac{3}{2}\left(1+\cos 20^0\right)$ **3.** $\frac{3}{4}+\cos 20^0$ **4.** $\frac{3}{2}$

Ans: **1**

Sol: $\cos^2 A + \cos^2 B - \cos A \cos B = \frac{3}{4}$, **if** $A + B = 60^0$

81. **Let the sum of the first n terms of a non-constant A.P.,** $a_1, a_2, a_3, \ldots$ **be**

$50n + \frac{n(n-7)}{2}A$**, where A is a constant, If d is the common difference of this A.P.,**

then the ordered pair (d, a_{50}) **is equal to:**

1. $(50, 50+45A)$ **2.** $(A, 50+45A)$ **3.** $(50, 50+46A)$ **4.** $(A, 50+46A)$

Ans: **4**

Sol: $S_n = 50n + \frac{n(n-7)}{2}A, t_n = S_n - S_{n-1} = (n-4)A + 50$

$d = A, a_{50} = 46A + 50$

82. **A committee of 11 members is to be formed from 8 males and 5 females. If m is the number of ways the committee is formed with at least 6 males and n is the number of ways the committee is formed with at least 3 females, then:**

1. $m+n=68$ **2.** $n=m-8$ **3.** $m=n=68$ **4.** $m=n=78$

Ans: **4**

Sol: $m = {}^8C_6 . {}^5C_5 + {}^8C_7 . {}^5C_4 + {}^8C_8 . {}^5C_3 = 28 + 40 + 10 = 78$

$n = {}^8C_6 . {}^5C_3 + {}^8C_7 . {}^5C_4 + {}^8C_6 . {}^5C_5 = 78$

83. **Four persons can hit a target correctly with probabilities** $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}$ **and** $\frac{1}{8}$

respectively. If all hit at the target independently, then the probability that the target would be hit, is:

1. $\frac{1}{192}$ **2.** $\frac{25}{32}$ **3.** $\frac{25}{192}$ **4.** $\frac{7}{32}$

Ans: 2

Sol: $1-P(\text{no one hiting the target})=1-\left(\frac{1}{2}.\frac{2}{3}.\frac{3}{4}.\frac{7}{8}\right)=1-\frac{7}{32}=\frac{25}{32}$

84. Let S be the set of all values of x for which the tangent to the curve $y=f(x)=x^3-x^2-2x$ at (x,y) is parallel to the line segment joining the points $(1,f(1))$, and $(-1,f(-1))$, then S is equal to:

1. $\left\{-\frac{1}{3},-1\right\}$ **2.** $\left\{-\frac{1}{3},1\right\}$ **3.** $\left\{\frac{1}{3},1\right\}$ **4.** $\left\{\frac{1}{3},-1\right\}$

Ans: 2

Sol: $(1,f(1))=(1,-2),(-1,f(-1))=(-1,0)$

$\text{slope}=-1\Rightarrow 3x^2-2x-2=-1$

$3x^2-2x-1=0\Rightarrow (x-1)(3x+1)=0$

$x=1\,(\text{or})\,x=\frac{-1}{3}$

85. The integral $\int \sec^{2/3}x\,\text{cosec}^{4/3}x\,dx$ is equal to (Here C is a constant of integration)

1. $-3\cot^{-1/3}x+C$ **2.** $-3\tan^{-1/3}x+C$ **3.** $3\tan^{-1/3}x+C$ **4.** $-\frac{3}{4}\tan^{-4/3}x+C$

Ans: 2

Sol: **put** $\int\frac{1}{\cos^{\frac{2}{3}}x\left(\sin^{\frac{2}{3}}x\right)^2}dx=\int\frac{1}{\cos^{\frac{2}{3}}x.\left(\tan^{\frac{2}{3}}x\right)^2.\cos^{\frac{4}{3}}x}dx\ (\text{put }\tan x=t)$

$=\int\frac{dt}{t^{4/3}}=t^{\frac{-1}{3}}.(-3)+c=-3(\tan x)^{\frac{-1}{3}}+C$

86. Let $p,q\in R$. If $2-\sqrt{3}$ is a root of the quadratic equation, $x^2+px+q=0$, then :

1. $q^2-4p-16=0$ **2.** $p^2-4q+12=0$

3. $p^2-4q-12=0$ **4.** $q^2+4p+14=0$

Ans: 3

Sol: $2+\sqrt{3}$ **also root,** $S.R = 2+\sqrt{3}+2-\sqrt{3} = -P \Rightarrow p = -4$

$P.R = 4-3 = q \Rightarrow q = 1$

So $p^2 - 4q - 12 = 16 - 4 - 12 = 0$

87. **If a tangent to the circle** $x^2 + y^2 = 1$ **intersects the coordinate axes at distinct points P and Q, then the locus of the mid-point of PQ is:**

1. $x^2 + y^2 - 16x^2y^2 = 0$ **2.** $x^2 + y^2 - 2x^2y^2 = 0$

3. $x^2 + y^2 - 2xy = 0$ **4.** $x^2 + y^2 - 4x^2y^2 = 0$

Ans: 4

Sol: **Let** $P(\cos\theta, \sin\theta)$ **be any point on circle, tangent at P is** $x\cos\theta + y\sin\theta = 1$

$A\left(\frac{1}{\cos\theta}, 0\right), B\left(0, \frac{1}{\sin\theta}\right)$

$P(x_1, y_1)$ **be mid point of** $AB = \left(\frac{\frac{1}{\cos\theta}+0}{2}, \frac{\frac{1}{\sin\theta}+0}{2}\right)$

$2x_1 = \frac{1}{\cos\theta}, 2y_1 = \frac{1}{\sin\theta}$

$\cos\theta = \frac{1}{2x_1}, \sin\theta = \frac{1}{2y_1}$

$\frac{1}{4x_1^2} + \frac{1}{4y_1^2} = 1 \Rightarrow x_1^2 + y_1^2 = 4x_1^2y^2$

Locus of $P(x_1, y_1)$ **is** $x^2 + y^2 - 4x^2y^2 = 0$

88. **The area (in sq. units) of the region** $A = \{(x, y) : x^2 \le y \le x + 2\}$ **is:**

1. $\frac{9}{2}$ **2.** $\frac{10}{3}$ **3.** $\frac{13}{6}$ **4.** $\frac{31}{6}$

Ans: 1

Sol: $x^2 \le y \le x+2 \qquad x^2 - x - 2 = 0$

Use $\dfrac{\left(b^2-4ac\right)^{\frac{3}{2}}}{6a^2} = \dfrac{\left(1-4.1.(-2)\right)^{\frac{3}{2}}}{6.1} = \dfrac{27}{6} = \dfrac{9}{2}$ **(or)**

Draw diagram and find $\int_{-1}^{2}\left(x+2-x^2\right)dx = \dfrac{9}{2}$

89. **Let** $f(x) = 15 - |x-10|; x \in R$. **Then the set of all values of x, at which the function,** $g(x) = f(f(x))$ **is not differentiable, is:**

1. $\{5,10,15\}$ **2.** $\{10\}$ **3.** $\{10,15\}$ **4.** $\{5,10,15,20\}$

Ans: **1**

Sol: $f(x) = 15 - |x-10|, x \in R$

$$g(x) = f(f(x)) = \begin{cases} x+10 & \text{if } x \le 5 \\ 20-x & 5 < x < 10 \\ x & 10 \le x < 15 \\ 30-x & \text{if } x \ge 15 \end{cases}$$

90. **A plane passing through the points** $(0,-1,0)$ **and** $(0,0,1)$ **and making an angle** $\dfrac{\pi}{4}$ **with the plane** $y - z + 5 = 0$**, also passes through the point:**

1. $\left(\sqrt{2},-1,4\right)$ **2.** $\left(-\sqrt{2},-1,-4\right)$ **3.** $\left(-\sqrt{2},1,-4\right)$ **4.** $\left(\sqrt{2},1,4\right)$

Ans: **4**

Sol: $\dfrac{x}{a} + \dfrac{y}{-1} + \dfrac{z}{1} = 1$ **is the equation of plane ……(1)**

$y - z = 0$ **……(2)**

$$\cos\frac{\pi}{4} = \frac{\left|\frac{1}{a}.0 - 1.1 + 1(-1)\right|}{\sqrt{\frac{1}{a^2}+1+1}\sqrt{1+1}}$$

$$\frac{1}{\sqrt{2}}=\frac{|-2|}{\sqrt{2}\sqrt{2+\frac{1}{a^2}}}\Rightarrow 4=2+\frac{1}{a^2}$$

$$2=\frac{1}{a^2}\Rightarrow a=\pm\frac{1}{\sqrt{2}}$$

So plane equation is

$$\pm\sqrt{2}x-y+z=1\quad \sqrt{2}x-y+z=1,\sqrt{2}x+y-z=-1$$

Check options $\left(\sqrt{2},1,4\right)$ satisfies second equation

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